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Proceedings of the regional peer review of impacts of agricultural drain maintenance in Beaver Creek on Grass Pickerel (*Esox americanus vermiculatus*), a fish species at risk

October 4–5, 2016
Burlington, Ontario

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

A regional science peer review meeting was held on 4 and 5 October 2016 in Burlington, Ontario. The purpose of the meeting was to provide advice on the effects of drain maintenance on Grass Pickerel (*Esox americanus vermiculatus*), a fish species at risk.

Participants of this meeting included Fisheries and Oceans Canada (DFO), the Ontario Ministry of Natural Resources and Forestry (MNRF), the University of Toronto, Portt and Associates, AHYDTECH Geomorphic, UEM Consulting, and the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA).

Beaver Creek is classified as a municipal drain and is located in the Niagara region in southern Ontario. The creek is characterized by low-gradient, temporally flooded riparian zones with low flow and dense aquatic vegetation, which represents optimal habitat for Grass Pickerel. In the fall of 2011 the western branch of Beaver Creek underwent drain maintenance and natural channel reconstruction. Due to concerns for the large resident Grass Pickerel population, multiple studies were conducted by DFO before, during, and after drain maintenance.

Three working papers were reviewed during the meeting, and included: fish and habitat surveys in the Beaver Creek area pre and post-construction; an age and growth assessment of Grass Pickerel; and a Before-After-Control-Impact (BACI) study on the effects of drain maintenance on Grass Pickerel in Beaver Creek. Two projects underway, genetic analysis of population structure and population modelling of the species at risk, were presented and discussed, as well as the findings from a graduate thesis focused on the movement ecology of Grass Pickerel. An existing mitigation guide for Grass Pickerel and its habitat was provided as a background document and updated with content from the recent findings. The working papers presented at the meeting will be published as Research Documents and the updated mitigation guide will be published as a Canadian Manuscript report of Fisheries and Aquatic Sciences.

The Science Advisory Report from the meeting provides information on the effects of drain maintenance and reconstruction activities on Grass Pickerel and its habitat, and recommendations on monitoring techniques and sampling protocols for the species. Updated mitigation strategies for Grass Pickerel and its habitat and potential alternatives for agricultural drain issues will also be incorporated.

This proceedings report summarizes the relevant discussions from the meeting and presents recommended revisions for the associated research documents. The Science Advisory Report, Proceedings and Research Documents will be published on the DFO Canadian Science Advisory Secretariat website as they become available.

Compte rendu de l'examen par des pairs régional sur les Répercussions de l'entretien des drains agricoles sur le brochet vermiculé (*Esox americanus vermiculatus*), une espèce de poisson en péril, du ruisseau Beaver; du 4 au 5 octobre 2016

SOMMAIRE

Une réunion régionale d'examen scientifique par des pairs a eu lieu les 4 et 5 octobre 2016 à Burlington, en Ontario. Elle avait pour objet de produire un avis sur les effets de l'entretien des drains sur le brochet vermiculé (*Esox americanus vermiculatus*), une espèce de poisson en péril.

Participaient à cette réunion : Pêches et Océans Canada (MPO), le ministère des Richesses naturelles et des Forêts de l'Ontario (MRNFO), l'université de Toronto, Portt and Associates, AHYDTECH Geomorphic, UEM Consulting et le ministère de l'Agriculture, de l'Alimentation et des Affaires rurales de l'Ontario (MAAARO).

Le ruisseau Beaver est classé comme un drain municipal et se trouve dans la région de Niagara, dans le sud de l'Ontario. Il est caractérisé par un gradient faible, des zones riveraines temporairement inondées avec un débit bas et une végétation aquatique dense, et constitue un habitat optimal pour le brochet vermiculé. Des travaux d'entretien des drains et de reconstruction du chenal naturel ont été effectués dans le bras occidental du ruisseau à l'automne 2011. Le MPO a réalisé plusieurs études avant, pendant et après l'entretien des drains en raison des préoccupations entourant l'importante population résidente de brochet vermiculé.

Trois documents de travail ont été étudiés pendant la réunion : des relevés des poissons et des habitats dans la zone du ruisseau Beaver avant et après la construction; une évaluation de l'âge et de la croissance du brochet vermiculé; une étude de type « témoin-impact-avant-après » (BACI) des effets de l'entretien des drains sur le brochet vermiculé dans le ruisseau Beaver. Deux projets en cours, une analyse génétique de la structure de la population et une modélisation des populations des espèces en péril, ont été présentés et examinés, ainsi que les conclusions d'une thèse de doctorat consacrée à l'écologie des déplacements du brochet vermiculé. Le guide d'atténuation existant pour le brochet vermiculé et son habitat, le document de base, a été mis à jour à l'aide du contenu de récentes constatations. Les documents de travail présentés à la réunion seront publiés à titre de documents de recherche et le guide d'atténuation, actualisé, à titre de rapport manuscrit canadien des sciences halieutiques et aquatiques.

L'avis scientifique découlant de la réunion donne des renseignements sur les effets de l'entretien des drains et des activités de reconstruction sur le brochet vermiculé et son habitat, et recommande des techniques de surveillance et des protocoles d'échantillonnage pour l'espèce. Les stratégies d'atténuation mises à jour pour le brochet vermiculé et son habitat, de même que d'autres solutions possibles pour résoudre les enjeux liés aux drains agricoles, seront également ajoutées.

Le présent compte rendu résume les discussions pertinentes tenues lors de la réunion et décrit les modifications recommandées à apporter aux documents de recherche connexes. Dès qu'ils seront disponibles, l'avis scientifique et les documents de recherche découlant de la réunion seront publiés sur le site Web du Secrétariat canadien de consultation scientifique du MPO.

INTRODUCTION

Beaver Creek in the Niagara River watershed in southwestern Ontario is classified as a municipal drain. Grass Pickerel (*Esox americanus vermiculatus),* a fish species of Special Concern under Schedule 1 of the *Species at Risk Act,* is found in southern Ontario and Quebec and inhabits agricultural drains in the Niagara region, including Beaver Creek. In 2011, maintenance was conducted in Beaver Creek to improve drainage and increase the drain's capacity. Grass Pickerel has specific habitat requirements such as dense aquatic vegetation, clear water, low flow, and temporally flooded riparian zones, all of which could be adversely affected by a traditional drain clean-out.

In the fall of 2011, the west branch of Beaver Creek underwent drain maintenance with natural channel design principles incorporated in the reconstruction in an effort to mitigate impacts of the maintenance on fish habitat. Due to concern over potential effects of the drain maintenance and reconstruction on Grass Pickerel habitat and population in Beaver Creek, Fisheries and Oceans Canada (DFO) Species at Risk Program requested advice from DFO Science. Specifically, they required guidance on the impacts of drain maintenance and reconstruction activities on Grass Pickerel in Beaver Creek and monitoring techniques focused on assessing effects on this species at risk.

As a result, a peer review meeting was held on October 4-5, 2016 at the Canada Centre for Inland Waters in Burlington, Ontario and via WebEx/Teleconference. The purpose of the meeting, as described in the Terms of Reference (Appendix 1) was to:

1. Determine the impacts of drain maintenance and reconstruction activities on Grass Pickerel populations in Beaver Creek;
2. Develop monitoring techniques that could be used to detect impacts on Grass Pickerel populations; and,
3. Update existing recommendations (Coker et al. 2010) and provide additional mitigation measures that could be used to minimize the effects of future drain clean-outs on Grass Pickerel.

The meeting participants included DFO, the Ontario Ministry of Natural Resources and Forestry (OMNRF), the University of Toronto, Portt and Associates, AHYDTECH Geomorphic, UEM Consulting, and Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) (Appendix 2). The meeting generally followed the agenda outlined in Appendix 3.

Numerous studies have been conducted recently on Grass Pickerel in its habitat within Ontario and Quebec, and participants were provided a background document and three working papers for review prior to the meeting. The background document was a mitigation guide for Grass Pickerel and their habitat (Coker et al. 2010), while the working papers included summaries of fish and habitat surveys in the Beaver Creek area pre- and post-construction (Colm and Mandrak in prep.), a study on age and growth characteristics of Grass Pickerel from two watersheds in the Ontario region (Casselman et al. in prep.), and a study on the effects of drain maintenance on Grass Pickerel in Beaver Creek (Glass et al. in prep.).

This proceedings document summarizes the relevant discussions from the peer-review meeting and outlines the conclusions reached and revisions recommended for the associated research documents. The working papers presented at the meeting will be revised and published as Research Documents and the updated mitigation guide will be published as a Canadian Manuscript Report of Fisheries and Aquatic Sciences (Coker et al. in prep.). The advice from the meeting is summarized in the Science Advisory Report (SAR) while technical details that

support the advice are published in the Research Documents. All reports will be published on the Canadian Science Advisory Secretariat (CSAS) website.

DISCUSSION

The Chairperson explained the objectives of the meeting and the DFO science advisory process. The Chairperson went on to provide the agenda for the two-day meeting, including a summary of the presenters and their associated topics. Draft documents that were provided in advance of the meeting were to form the basis of the discussion; additionally, a summary of results from a graduate thesis, preliminary results from a population genetic analysis, and population modelling outcomes were to be presented and discussed. Participants were encouraged to be actively involved in the meeting by asking questions and contributing their knowledge and expertise with the goal of reaching agreement on the final conclusions, recommendations, and advice.

PRESENTATION ON GRASS PICKEREL GENERAL INFORMATION

Presenter: Julia Colm

Summary

The presenter began by providing information on the life history, distribution, habitat, and food preferences of Grass Pickerel in Canada. The species is the smallest member of the pike family, a top predator, and is known to inhabit 14 locations across southern and central Ontario and one location in southwestern Quebec. Its preferred habitat includes margins of seasonally flooded riparian areas, slough, and associated wetlands that are heavily vegetated, with shallow and clear waters and little to no flow. Primary threats to the species in Canada include agricultural drain maintenance, invasive species, climate change, and disease. The functions, features, and attributes table (FFA) was presented.

The participant moved on to address the research question, which was to determine the factors that affect Grass Pickerel distribution within a watershed. The specific questions were:

1. What is different about sites where Grass Pickerel is present vs. where it is not present?
2. What makes the best quality habitat?
3. Are there biotic interactions or a consistent community where the species is present?

The statistical analyses used to address these questions included linear models (question 1), zero-inflated Poisson General Linear Model (question 2), and non-metric multidimensional scaling (NMDS; question 3). With regards to the first question, the presenter explained that at the reach scale, baseflow index and reach slope were significant factors in determining Grass Pickerel presence. For the second question, the site-scale variables that proved to be significant predictors of Grass Pickerel abundance included channel cover, wetlands in the floodplain, and the Lake Ontario west watershed. Lastly, fish community sampling showed that similar fish species were present in all sampling locations (barring a few differences), whether or not Grass Pickerel were detected.

The presenter then described other regions that had been sampled where Grass Pickerel had been noted historically. This included small waterbodies in Quebec that were visited in 2012 through 2014, where both active and passive gear types were used to sample the fish community. A total of 28 Grass Pickerel were captured at 19 sites in eight waterbodies. High vegetation cover was a common factor (50–100% coverage). The presenter explained that the species was most abundant in the southwest portion of Lake Francis, likely because this region

had more suitable habitat than the other locations, the majority of which were degraded, developed, and had barriers between historic sites. The presenter then discussed population trends in Jones Creek, a location in Ontario that had been sampled in 1960 with high catches of Grass Pickerel at the time. Results showed that while the historical fish community in Jones Creek consisted of diverse piscivores, specialist minnows and darters, and many Grass Pickerel (n = 550), the 2013–14 fish community was composed of small-bodied species, omnivores, and few Grass Pickerel (n = 26). The presenter attributed this change to an increase in beaver activity, land-use changes, persisting effects of historical land uses, and climate change.

The presenter concluded the presentation by mentioning that the drain mapping tool kit was data deficient in some regions where Grass Pickerel occur in Ontario, including Point Pelee, Lake St. Clair, Old Ausable Channel, and the Cornwall area.

Discussion

A participant inquired as to whether the FFA table had been distributed to the group for review and the presenter acknowledged that they had not sent it and would do so by the end of the day.

A participant was unclear about the mapping of drains and mentioned that certain drains labeled on engineering reports were not on the presenter's map. The presenter clarified that the map shown was not all of the municipally classified drains but was created with a DFO drain mapping tool kit and was modified to show the sites being discussed.

Another participant requested clarification on the term 'cover', as the presenter had stated that Grass Pickerel tend to be detected where there is a lot of cover. The presenter explained that cover refers to in-stream vegetation, as well as overhanging vegetation, channel cover, and any riparian trees that fall into the stream. The presenter suggested that perhaps the Grass Pickerel are responding to the shade factor associated with these types of covers, in addition to using them as refuge.

A participant asked how much variation existed in stream width among sites, and the presenter explained that there was a lot of variation. They indicated that 0.8 m is generally the water depth where all Grass Pickerel were captured; however, this did not come out as significant in the linear model, and the presenter is currently working on other methods of statistical analysis to try to tease this out.

A participant then asked whether the current DFO drainage mapping (i.e., the DFO drain tool kit used by the presenter) would be overlapped with municipal layers to enhance the knowledge of locations of water courses classified as drains. A discussion followed whereby it was ascertained that the Fisheries Protection Program (FPP) of DFO has been working to revise the drain tool kit and that currently a team of people are sampling drains and classifying them so that this updated information can eventually be incorporated into DFO's system.

PRESENTATION ON BEAVER CREEK SAMPLING SUMMARY

Presenter: Julia Colm

Summary

The presenter indicated she would talk broadly about trends in fish community and habitat across Beaver Creek through time. The presenter provided details about the Beaver Creek watershed and the south, west, and north branches that were sampled throughout the study. Drainage was an issue in the west branch and there were concerns about incorporating drain cleanouts as they alter essential elements of fish habitat (i.e., heavy vegetation and woody

debris, low gradients), and a large population of Grass Pickerel exists in this drainage system. The drain maintenance project incorporated natural channel design principles in an effort to mitigate impacts on fish habitat. In the fall of 2011, a 1 km section in the west branch was reconstructed with five in-line pools and two offline pools. Further downstream one in-line and one offline pool were created and two Newbury weirs were installed.

The presenter summarized a Before-After-Control-Impact (BACI) study conducted by DFO Science where Grass Pickerel movement was tracked. Ten sites were monitored on a rotating basis from May to August from 2009–2013 and in 2015 using PIT tags and radio telemetry. This incorporated three years of monitoring before and four years after the construction in 2011. Multiplexer stations were set up at eight sites. Uneven sampling was identified as an issue, since sites were not sampled equally each year and some sites changed through time. Fish community surveys were conducted at each site (three seine hauls) and habitat was assessed for physical characteristics, water chemistry, vegetation and substrate, and level loggers were installed and checked routinely. The presenter explained that descriptive statistics were summarized for each site per year and Kruskal-Wallis tests were conducted to compare parameters between years for each site.

The presenter summarized the fish community results. Grass Pickerel were detected 91% of the time. There were no differences in mean catch per unit effort (CPUE) among years at any site, and the highest catches tended to be at Eagle and Stevensville sites, while the lowest were at Ben's station. Of 4,971 Grass Pickerel caught, 2,019 were tagged with PIT tags and 381 were recaptured. The presenter noted the following important trends: abundance of Grass Pickerel decreased twice, once after 2009 and then again after 2011. The presenter hypothesized that the former decline could be related to density-dependent factors, while the latter was likely a result of a severe drought that occurred in 2012. The presenter summarized site information, including that Bowen, Garrison East, and Bertie had the most Grass Pickerel (56%) while Garrison West always had the lowest abundance. The presenter then displayed bar graphs of Grass Pickerel CPUE in the constructed pools and stated that the numbers decreased in the downstream direction. A participant asked for clarification of the direction of flow and the presenter explained that the flow of water starts at pool 4 and flows downstream to pools 3 and 2, and the Grass Pickerel seemed to colonize the pools against the flow of the creek, downstream to upstream. The presenter then talked about trends in abundance of young-of-year (YOY) and showed that young were caught more frequently at the Bowen Rd., Stevensville, and Winger sites. The presenter showed an example of Grass Pickerel size and condition at one of the sites (plotted using a cubic function that represents average length to weight relationship) and explained that it was representative of most sites. The presenter summarized that generally Grass Pickerel were smallest in 2013 and their body condition was most variable in 2009 and poorest in 2012.

The presenter concluded with a summary of some trends in habitat variables. Most variation occurred at Garrison West, which they thought made sense as this was a reconstructed pool. College station also exhibited high variation, and the presenter suggested this may be because it is located at the mouth of the creek. Turbidity was low at Bertie and high at Garrison West, and pH was high throughout the constructed reach. Conductivity was exceptionally high at Garrison East in all years. The presenter explained that level logger data showed low water levels and high temperatures in 2012, and noted that there was a delayed recovery of vegetation in the constructed reach.

The presenter concluded with a slide highlighting the important notes, including that Garrison West station and the constructed reach always had relatively low abundance of Grass Pickerel. In the presenter's opinion the drain maintenance is likely to have little permanent impact on

Grass Pickerel in the west branch, whereas it would have a larger impact on their population in the south branch.

Discussion

One of the participants asked whether a section of a stream was totally dewatered during construction, and the presenter replied that it was. Another participant explained that while there were dewatered sections, they were only 25–30 m long at a maximum, and that fish were always rescued and returned immediately downstream of the dewatering location. They went on to explain that the work area was isolated with a clay cofferdam and the dewatering typically only lasted a day.

There was a discussion about Garrison West and East sites. A participant noted the large disconnect between the two sites and asked if there were differences in other members of the fish community. The presenter did not recall and said that they would check; she knew there was greater species diversity at Garrison West. Another participant explained that Garrison West is highly channelized and has very little connection to its floodplain; in addition there is a high probability that groundwater is upwelling in the tributary in Garrison East, which is likely why the conductivity is so high. The presenter explained that while there were differences in habitat between the two sites, such as substrate, it did not come out clearly in the analysis. This was followed by a question regarding whether the slopes had been statistically analyzed and the presenter said she had not tested this specifically, but could do so.

A participant inquired as to the definition of pools. Another participant explained the construction process and that pools were designed to be widened and deepened significantly, about four to five times their current diameters. They clarified that Pool 4 is dug into an area that had no pool because bedrock was located just downstream. Structures were also placed at the head of each pool that promoted helical vortex which helps to keep them deep. The participant went on to explain that due to entrenchment the channel had lost its floodplain connectivity, and is the reason they created such deep pools. The participant offered to provide design details if anyone was interested. It was confirmed that this answered the original question. Another participant explained that based on their assessments of the creek they have found that the creek is widening in many cases, particularly where the soil is exposed and sediment is finer.

A discussion followed about identifying critical habitat or hot spots for species at risk such as Grass Pickerel. The presenter thought that the hot spots would be easy to identify and likely only require one survey of the creek, and surmised that if one Grass Pickerel was caught it would be a good indication of a hot spot. A participant noted that some of the predictive variables that were discussed in this and the preceding presentation could be used to provide information at the site level. Another participant wondered if sampling was necessary given the FFA table and the models, but the presenter explained that more data would be beneficial so that some of the models can be improved. One of the participants wondered if the lack of a strong model could be attributed to the fact that some of the physical variables were not collected properly, since the presenter had mentioned that there were differences in habitat variable collections. The presenter clarified that the data in her thesis were standardized but that Grass Pickerel were caught in low numbers at most sites and if more could be captured across their entire range it would help strengthen the models.

There was a discussion about the type of agricultural land use surrounding the tributaries, with one participant pointing out that this could affect the resulting water chemistry, soil health, erosion control, and subsequent impacts on Grass Pickerel. The presenter acknowledged the lack of detail on this subject and explained that during habitat assessments they classified the land use into four categories, and noted, for example, whether it was a row crop. Another

participant confirmed this, and indicated that around the construction sites there were some spill ways for erosion control but that this varied from farm to farm. It was suggested that DFO partner with OMAFRA to determine specific pathways that affect these ecosystems and for OMAFRA's soil conservation strategy to be sent around for the group to see.

PRESENTATION ON POPULATION GENETICS OF GRASS PICKEREL IN CANADA

Presenter: Nathan Lujan

Summary

The presenter opened by explaining that they were tasked with evaluating the genetic structure of Grass Pickerel in Ontario and Quebec using a Next Generation Sequencing approach. Tissues were analyzed from a total of 45 individuals collected from 12 regional clusters. Samples were collected from Abino Drain (6), Big Forks Creek (8), Lake St. Clair (3), Long Point (2), Lyons Creek (3), Prince Edward County (1), southern Lake Huron (6), lower St. Lawrence River (7), upper St. Lawrence River (1), Tea Creek (7), and Twenty Mile Creek (1). Analysis of an additional 24 samples from the Severn River drainage basin is pending. Analyses resulted in the isolation and sequencing of 5,188 loci of 56 base pairs each, totaling approximately 300,000 base pairs. Each locus was present in at least 40 of 45 individuals assessed in the analysis and 1,001 single nucleotide polymorphisms were identified and used as the basis for a Bayesian STRUCTURE analysis. Initial results of the STRUCTURE analysis showed that there is no evidence of any population structure throughout the sampled range; however, more analyses need to be conducted with the Severn River watershed population samples included.

Discussion

A participant asked the presenter to elaborate on single nucleotide polymorphisms for the benefit of the audience. The presenter explained that single mutations can be used to infer genetic structure, and if one population is segregated and not breeding with another population then mutations would be expected to accumulate over time and a measure of uniqueness could be developed for that population. Furthermore, Next Generation Sequencing is a technique that is relatively new compared to haplotype or microsatellite methods, and allows for the evaluation of thousands of loci.

A question followed about whether the SNPs (single-nucleotide polymorphism) are all in coding regions and what the estimate of the mutation rate is. The presenter clarified that this approach digests the genome using restriction enzymes, which are enzymes that identify single four to six base pair repeats in the genome and cut the genome at those points, which results in a "shotgun" distribution of loci throughout the genome. It is unknown whether these sections are coding or non-coding, the result is just an indicator of genetic diversity. The presenter stated that at this time there is no calibration point for Grass Pickerel, which is needed to gauge a mutation rate. They continued on to say that they could look into what other researchers are doing with regards to using an 'assumed' mutation rate.

A participant mentioned that pairwise comparisons may be helpful, because they had expected differences would exist among some populations, particularly the St. Lawrence River population. Another participant asked about local adaptations and how we should interpret local and regional trends in order to provide perspective for scientific advice. The presenter reported that based on these results, we can treat what we know from one population as applicable to all populations across their range.

PRESENTATION ON EFFECTS OF DRAIN MAINTENANCE AND RECONSTRUCTION ON GRASS PICKEREL

Presenter: Bill Glass

Summary

The presenter opened with an introduction to the Beaver Creek study site and the methods. Pool habitats were sampled using a 9.1 m bag seine, one to six times per year, before (2009–2011) and after (2011–2013, 2015) construction. The presenter outlined the analysis used to evaluate the BACI study, which was a factorial ANOVA; if there was a significant interaction term ($p<0.05$), that implied a significant effect of maintenance on the variable in question. The fish community was analyzed using the *Adonis* function in vegan package in R. Multiple temporal and spatial scales were conducted on both the habitat variables and fish CPUE.

The presenter moved on to the results and explained that after the first survey post-reconstruction, where five Grass Pickerel were captured in offline pools, there were no subsequent captures and these sites were removed from the analysis. The presenter outlined the results and then compared the findings from Beaver Creek's natural channel reconstruction to what would be expected with traditional drain maintenance.

Traditionally, there would be increased turbidity and nutrients (nitrogen and phosphorus), as well as increased water velocity and water temperature as a result of drain maintenance. The presenter described that in Beaver Creek there was no effect on Secchi depth (i.e., turbidity), and while nutrient concentrations were not assessed, conductivity did increase. Results showed no effect on water velocity in Beaver Creek but did indicate increased water temperature. The presenter continued to explain that traditional drain maintenance tends to decrease vegetation and result in loss of sensitive species; while the former trend was observed in Beaver Creek, there was no perceived change in fish community and an increase in Grass Pickerel abundance was observed.

The presenter provided some recommendations for drain maintenance. First, the creation of natural channel morphology with riffle-pool habitats will help to decrease velocity, provide low velocity pool habitat, and increase habitat heterogeneity. Second, deeper pools are beneficial, as they likely insulated the Grass Pickerel population from a drought-induced mortality event. Lastly, the presenter explained that it is important to consider the source population and its dispersal ability for recolonization purposes, and to stagger implementation of drain maintenance in order to allow fish species to recolonize.

The presenter then proposed some recommendations for monitoring, including: sample at least three years prior to a maintenance project or as long as possible pre-construction; and, monitor at least four years post-construction, as habitat effects were short-lived and vegetation and conductivity recovered within four years. The presenter added that research suggests fish populations recover within three years of an impact. Other factors the presenter thought were important to consider included choosing control sites that are as similar to impact sites as possible and to standardize sampling effort between sites and years.

Discussion

One of the first points brought up by a participant was the wording regarding maintenance and the lack of impacts on Grass Pickerel. A discussion followed on the definition of maintenance and the specific reference to this project, and a member from FPP agreed to provide appropriate wording to the presenter so that the specifics are captured in future documents.

A discussion started on the topic of vegetation, because a participant observed that vegetation has not recovered in the reconstructed site over three or four years despite the fact that it was seeded. The presenter postulated it may be because the creek dried up or due to high turbidity, and another participant explained that none of the plantings were successful in 2012 as a result of the drought. A group member wondered if anyone had an idea of the natural recolonization rate for vegetation, as other experts have suggested vegetation would recover in one to two years. The discussion continued with a participant questioning whether the seed bank had been removed during reconstruction, and concluded with a note to discuss how to replant and maintain a seed bank and the effect of drought events in years subsequent to drain projects.

Water depth analysis was discussed next. Participants wondered whether mean water depth was the best measurement to use, since water depth varied from May to August. It was suggested that only July and August values be used, and that it might be useful to assess water level logger information. A question was posed about the variability of the stream width and a participant responded that width is fairly invariant on entrenched streams, and provided some details with regards to the construction of the new pools.

The conversation then reverted back to the seed bank and whether it was known how far down excavation went during reconstruction. A participant explained that a wide bucket was used and spoils were piled on the bank and surrounded by a sediment control fence for the majority of a 900 m reach. They did not know what happened to the sediment piles after the reconstruction, but remembered the property owner was interested in using them for his row crop. The participant then mentioned the high turbidity in the west branch relative to the south branch, and explained that they had noticed a lot of carp during construction. Other members confirmed that some carp and Goldfish had been captured in 2015. It was clarified that the new agency responsible for monitoring will commence from hereon in. Another participant postulated that perhaps lack of flow is affecting the movement of the seed bank downstream after which discussion ensued on throughflow. A participant mentioned that the engineering report should contain information on what happened to the spoils, and that there are multiple options for removing them from the bank and helping farmers with erosion control options.

A participant asked about the dredged soils that were sidecast within the floodplain and whether the dredgeate was ever removed, because otherwise it would seem likely to be re-suspended. A participant estimated that approximately 85% of sidecast was pushed into these stockpiles and the remaining 15% was transferred into a berm about 30 m long, whose function was to capture soil before it entered the water.

A discussion followed about channel design and definition, channel characteristics in the constructed pools, and flow and sediment mobilization. It was shared that locations two and three (which was clarified to correspond to pools 1 and 2) are more prone to erosion and turbidity because of large trees and their roots that surround the bank, and not due to flow. Another participant confirmed this, and mentioned the inclusion of two Newbury weirs that were installed in an effort to force flooding to a previously abandoned floodplain. A participant explained that that area had been sampled in 2012 after the drought and that it should be sampled more adequately in order to determine if YOY are using the habitat.

The participants then talked about post-monitoring requirements that were identified as part of this work permit. It was clarified that five years of moderate sampling and 15 years of total sampling were required, based on two to three life cycles of Grass Pickerel. Participants believed that reports had been written for each of 2012–15 monitoring years, and it was emphasized that these reports should be made available to the entire group. Along those lines, a participant asked whether there have been any upstream impacts or changes that could have affected the system downstream, but only limited anecdotal information was known.

A member commented that based on presentations so far there have been interesting changes in the Grass Pickerel community; they further inquired as to whether the natural channel design has met the original goals of the agricultural drainage issue. The opinion of one participant was that the drainage has drastically improved and that the channel appears to have stabilized although there are some sections with sediment offloading and erosion issues, while another participant supposed the municipality was content with the drainage, as their focus currently seems to be erosion issues. It was reiterated that the berm design is being promoted in these types of projects because it helps to hold water for 24 hours, which helps contain the sediment. The ideal design is to have a series of them throughout the field. A contributor made an observation that while one of the constructed pools is functioning well, two of them are mostly U-shaped and experience a lot of shear stress, which could have been avoided with a different channel shape, resulting in lower sedimentation than is currently occurring.

PRESENTATION ON MOVEMENT OF GRASS PICKEREL IN BEAVER CREEK

Presenter: Nick Mandrak

Summary

The presenter opened the talk by giving a background on stream fish movement. In general, stream fishes migrate for feeding, overwintering, and spawning purposes. However, the majority of individuals do not migrate, and spend the entirety of their lives in a 20–50 m stream segment. Little is known about the migration or dispersal of Grass Pickerel. Drain maintenance could affect the Grass Pickerel population by disrupting migration and dispersal or by direct effects to sedentary individuals. The purpose of this graduate thesis project (Kramski 2015) was to:

1. Determine if Grass Pickerel undertake long-distance movement (0.5–1 km);
2. Determine if they exhibit migration or dispersal patterns; and,
3. Determine the spatial, temporal, and phenotypic variables that could affect Grass Pickerel movement.

Multiplexer stations connected to antennas were set near culverts to facilitate access. Grass Pickerel were implanted with PIT tags and tracked from May to November in 2009 and from April to December in 2010. Locations were recorded when an individual PIT tag was detected by an antenna at a multiplexer station and the direction of movement was determined when an individual was detected at successive antennas. Movement between three sites, one site on each branch of the creek, was analyzed in this study. Detection at more than one site indicated movement and whether the movement was dispersal or migration was determined by the proportion of individuals moving, the timing of movement, and whether there was a subsequent reversal of direction. Multi-state models and how they can be used to study movement were described. There are three states, A, B, and C, representing each of the three sites. The model can calculate the probability of moving between states, the probability between time t and t+1, and the probability of survival and detection. The baseline model for each year was used to assess the probability of survival and detection, and the best model then proceeded to the next step where variables affecting movement were assessed. Three separate model sets were run (spatial, temporal, and phenotypic) and the best model was carried over to the final step. These models were then evaluated to find the best model linking spatial, temporal, and phenotypic models.

Results showed evidence of movement by a small proportion of Grass Pickerel in both years (5% in 2009 and 2% in 2010). No clear peaks in detection that would be indicative of migration were apparent. Furthermore, if migration were occurring there should be movement into the

south branch of the creek at a specific point in time and out of it at another point in time, but this was not observed. Other observations included no movement between the west and south branch, and movement between the west and east branch and east and south branch, in both directions. Results also showed that both temporal (i.e., seasonal) and phenotypic (i.e., condition) variables were predictors of movement. The following conclusions were inferred from the study:

1. Grass Pickerel can undertake movements at the scale of drain maintenance;
2. there was no evidence of a seasonal migration; and,
3. movements tended to be made by larger individuals in better condition than smaller individuals in poorer condition, and later in the season in 2009 but throughout the season in 2010.

Discussion

After the presentation a participant commented on the utility of the data in identifying important areas for Grass Pickerel. The participant went on to inquire as to whether the tags would last throughout the life cycle of a fish, and what spawning conditions are. The presenter replied that they do not know the spawning condition, and since fish in better condition were moving it implies the movement is potentially more spawning-related than food-related.

A discussion continued on the movement trends of Grass Pickerel. A participant noted that the Bowen Road site had the most YOY, with other high abundances occurring in sites around the confluence. It was suggested that the YOY could be moving, but this conflicts with the finding that those moving are the largest fish in best condition. Others suggested analyzing the data for triggers such as extreme events, seasonality, and water temperature. The presenter agreed that these factors should be analyzed. They went on to explain that the resolution of the detections was restricted spatially and that they are unable to calculate a rate of movement.

A participant inquired whether the transport or downstream movement of YOY is similar to that of Northern Pike. The presenter explained that this tagging study could not provide specific details to that question, but it could potentially be inferred that there was higher YOY downstream with some upstream movement. Another participant added that the best YOY habitat is around Garrison East (southern branch) and Eagle Road (north, near the mouth), in their opinion. The participant continued to say that since Beaver Creek is not very long, they would expect the Grass Pickerel to use the habitat throughout the system and not just near the headwater as the literature suggests. Through discussion it was noted that Grass Pickerel may be able to live their entire lives within a small area, 1+ km, with density-dependent effects potentially occurring at specific sites with high recruitment like Bowen Road.

PRESENTATION ON AGE AND GROWTH OF GRASS PICKEREL IN BEAVER CREEK

Presenter: Julia Colm

Summary

The presenter opened by explaining that little information exists on Grass Pickerel age and growth or population dynamics from anywhere in its range. A few studies exist, including one that focused on aging a Grass Pickerel population in a St. Lawrence River tributary in eastern Ontario, using scales. Other studies have focused on populations in the U.S. The presenter outlined the objectives of this study, which were to determine age distribution, growth and mortality rates of Grass Pickerel in Beaver Creek, as well as to conduct structure comparisons

between scales and cleithrum to determine the most suitable aging method. The presenter explained that cleithrum interpretation provides reliable results but is a lethal method, and since Grass Pickerel are a species at risk, a non-lethal method such as scale extraction would be preferential.

The presenter then identified the methods of the study. Grass Pickerel were collected from Beaver Creek in 2009 (n = 153) from two sampling events in June, and in 2011 (n = 111) throughout the entire summer from several sites. The presenter explained that based on preliminary analyses of 2009 data, YOY were targeted in 2011 to better understand cleithral growth during the first season. Fish were measured, weighed and sexed, and cleithrum was collected in both years, and scales in 2009 only. Jones Creek in eastern Ontario was also sampled in 2011, although the presenter was unsure of the sample size.

The presenter moved on to the results from Beaver Creek. The population from 2009 was characterized by older and larger individuals (1 to 8 years old) while the 2011 population was composed mostly of YOY and some older fish (0 to 6 years old). The presenter showed a total length histogram and explained that some sites exhibited a bimodal shape and others a unimodal shape, which is comparable to other studies. The presenter inferred that Grass Pickerel age structure will vary temporally and spatially and that this may be related to year-class strength. The presenter showed results from reconstructed length-at-age data; growth rates were higher in 2011 when fewer and smaller individuals were present. They suggested that high density of Grass Pickerel in 2009 may be the reason for the slow growth observed in that same year. Data from Jones Creek suggested Grass Pickerel had relatively fast growth initially, after which growth slowed to a rate below the Beaver Creek population in both years; this may be because the population is located farther north.

The presenter discussed some identification issues. In 2009 it was uncertain whether there was an ancillary check, known as pseudoannulus, on the cleithra. This can happen during the first year of growth. Eighty percent of the Grass Pickerel from the 2009 samples had the pseudoannlulus formation compared to 20% of the 2011 sample, and 78% of the 2011 Jones Creek sample. The presenter explained that slow growth rates can lead to the development of this larval check, as can high density or a change in diet. The presenter went on to describe mortality rates, which were 46% in 2009, including higher mortality for females, which is uncharacteristic of escoid populations.

Lastly, the presenter described the results from the two aging methods, and found that scales consistently underestimated age compared to cleithra interpretation. The presenter showed that based on length-at-age intervals, length could potentially be used as a proxy for this species in Ontario. The presenter concluded with some take home messages, including: the 2009 Grass Pickerel abundance was not typical and potentially led to density-dependent effects on growth; that scales are not a reliable method of aging Grass Pickerel; and, that long term datasets are required to identify trends.

Discussion

After the presentation a participant asked for clarification on whether the 2011 data were pre-construction. The presenter confirmed that this was pre-construction sampling. Another participant asked whether there was a possibility of gear affecting the results between 2009 and 2011. The presenter did not think so as they used the same gear type and visited the same sites. They speculated that perhaps in 2009 the Grass Pickerel spawned later, which may be the reason no YOY were captured. Another participant clarified that 2009 was a non-random sample; the fish were being held in a pen while surveys were ongoing and for unknown reasons all of the fish died. There was a lack of YOY during that sampling event, which is the reason

YOY were targeted in 2011. The participant explained that there is a bias and the entire dataset should be used to avoid that. The presenter acknowledged this.

Another participant asked how data were converted into year-class strength. The presenter was unsure as they did not run the analysis. The participant observed that the analysis that was conducted is essentially the frequency of fish born in that year and not an actual year-class sample. They suggested taking the growth curve and doing a length-age key to try to assign ages to all of the fish in the sample. The presenter took note and will re-evaluate.

A participant asked for clarification regarding sample size in the graphs and the presenter agreed to look into the analysis. It was brought up that there was not enough information provided about the calculation of mortality rate estimates, and the presenter explained that they were waiting for the first author to provide more details. It was noted that the research document will need substantial revisions and review before it is included for reference.

A discussion followed regarding the density-dependent effects. One participant noted that the effects on growth seemed substantial and that some of the consequences of drain activities could be extended to growth, while another participant cautioned against using language that implied cause and effect. The participant warned against using an interesting observation and linking it to potential impacts of drain maintenance.

A participant asked whether the consulting company in charge of monitoring post-construction was monitoring the fish community. The representative answered that they were monitoring both fish and habitat and the results will likely be present in the next quarterly report.

PRESENTATION ON POPULATION MODELLING AND MAPV

Presenter: Adam van der Lee

Summary

The objective of the study was to determine how habitat quantity affects Grass Pickerel population size. The presenter began with an outline of the presentation, and then described the modelling steps. The model used was an age-structured matrix with the following parameters:

- maximum age: 7
- eight stage matrix (0–7)
- age at maturity (2–4)
- fecundity at size, based on a Wisconsin population (Kleinert and Mraz 1966)
- survival at size, based on a length-dependent mortality schedule (Lorenzen 2000) that ranged from 42–65% from age 1 to age 7
- variation, incorporated into the model through stochastic simulations

The majority of the model was parameterized based on length-weight relationships. A growth curve was based on unpublished data from Casselman and length-weight information was based on 2010 data from Beaver Creek.

Habitat variables in the model included spawning, YOY, and age 1+ habitat. Habitat was incorporated through density-dependent effects where survival was reduced by a proportion based on the ratio of habitat available to current habitat required. Required habitat for YOY and age 1+ was calculated for each individual based on size at age (Minns 2003). Spawning habitat requirements were estimated from length based on values in the literature for Northern Pike

(Minns et al. 1996), and multiple area sizes were compared, including small (2 m^2), large (10 m^2), and extreme (80 m^2).

At this point, a participant asked where the value for the extreme case originated, as it seemed larger than any other species that has been assessed. The presenter answered that is was an observational value from spawning Northern Pike (5 per acre) and acknowledged that it was very large.

Available habitat estimates based on GIS analysis of the main tributary ranged from approximately 94,000 m^2 (based on the channel itself) for age 1+ habitat to ~ 318,000 m^2 for spawning habitat (based on a simulation of the flooded area during spawning season).

A participant asked whether that area was flooded within the entire Beaver Creek watershed, but the presenter was unsure, as this part of the analysis had been conducted by someone else. Another participant said they would look into it.

The presenter continued, and explained that two scenarios were estimated for YOY, whose habitat depends on how quickly water recedes in the spring/summer and how they share habitat with older fish. The estimated available habitat ranged from approximately 4,700 m^2 when YOY are limited to the floodplain, to 90,700 m^2 when YOY have access to both the flooded area and the channel.

Sensitivity analysis was developed with two elasticity scenarios: when population growth is equal to 1 (e.g., steady) and when growth rate is at a maximum for this species. One analysis focused on the vital rates, which refer to survival and fecundity, while the second analysis focused on the parameters that were used to estimate the vital rates. Vital rates were more sensitive to survival rate of pre-adult fish but not sensitive to fecundity values, and the parameters were sensitive to the fecundity exponent, asymptotic length, and mortality at unit length. The latter two are values that were not estimated from Beaver Creek specific data.

The MVP was defined as the number of adults (age 3+) required to maintain a population over 100 years for a desired probability of persistence. A probability of 15% chance of catastrophe per generation was included (every 5.4 years). For probabilities of extinction of 0.05 and 0.01, 510 and 1,653 adults were required, respectively. MVP values were used to estimate MAPV area required. To maintain a population of 1,653 adults required 14,853 m^2 of age 1+ fish habitat, 4,921 m^2 of YOY habitat and 7,992 m^2 of spawning habitat. Area requirements, however, are likely greater than the MAPV because of cumulative density-dependent effects that act on the three types of habitat.

Simulations incorporating a Leslie matrix to project population size in one-year intervals while accounting for stochasticity and density-dependence were conducted to determine how changes in habitat affect mature adult population size. Simulations were repeated with differing amounts of either spawning or YOY habitat, while keeping the other two habitat types constant. The mean population sizes of mature fish over a 100 year timeline were compared. The simulations showed that age 1+ habitat is the most limiting in this system and defines the mean long term population size, at approximately 6,000 mature fish; for YOY, habitat is limiting near sizes of 60,000 m^2; and, spawning habitat is not limiting unless spawners require larger areas, or if flooded area is reduced below 100,000 m^2. Actual spawning requirements, however, are unknown.

Several uncertainties are inherent in the Grass Pickerel habitat supply model including:

- The model assumes that all flooded area is suitable habitat for spawning;
- The required spawning area is not known;

- The extent that YOY and age 1+ Grass Pickerel share space is unknown;
- The required space per individual is based on allometry and not measured densities from the population; and,
- The model was sensitive to the fecundity exponent and mortality at unit length, parameters that were based on other populations/published equations.

Discussion

After the presentation there was a question about the comparability between the MAPV values and the simulations of flooded area within Beaver Creek. The presenter explained that they were not directly comparable, because MAPV adults were considered mature at age three but in the simulations maturity was defined as age two. The presenter indicated that if the data are revisited they will use the same definitions and compare the two values.

A participant asked about the definition of spawning area. It was explained that this is the area required by an individual to spawn and to have those eggs survive. Literature equations were used for this value based on Northern Pike work. The presenter explained that if females have less than this amount of area, then density-dependent effects can occur, which is assumed to affect egg survival. The presenter highlighted results that showed there were some differences in spawning area required between small and large values but that the extreme was a completely different output. A participant clarified that the linear relationship signifies when the required spawning area is much higher than the habitat available. This was confirmed and it was noted that there was no evidence to indicate that Grass Pickerel need the extreme amount of habitat that was modeled. It was suggested that the slides from the presentation be included in the proceedings document if they would be considered helpful for interpretation.

Another participant described how they had witnessed Grass Pickerel clustered one day in groups of three to four under vegetation, but was unsure whether this was a spawning event. Others have suggested that the fish may move in small groups to spawn.

A discussion followed about how applicable these types of estimates are to other Grass Pickerel populations. It was explained that the model output is influenced by location-specific factors like growth and mortality rates. Fecundity could have some influence, but those relationships don't tend to change a lot among populations; however, in this case fecundity was extrapolated so it is an unknown factor. Another participant commented that it would be helpful if this model could be used for other populations as the estimates are often generic.

A participant asked whether it was acceptable that there were no population-specific estimates for MAPV. A participant explained that space requirements for fish are body size related, which is what that approach was based on. This will differ among species, however, since some fish prefer to be crowded. The participant explained that if better information exists for individual Grass Pickerel area requirements, it should be used as opposed to generic estimates.

PRESENTATION ON UPDATES TO GRASS PICKEREL MITIGATION GUIDE DOCUMENT

Presenter: Julia Colm

The presenter began by referring to the mitigation guide document by Coker et al. (2010) that provides a detailed overview of threats to Grass Pickerel and mitigation strategies to protect its population and habitat. All of the participants were reminded that the FFA table and the mitigation document were going to be sent to everyone for their input in time for discussion the

following day. Another participant explained that this document, Coker et al. (2016), is meant to be published as an updated review document.

The presenter went on to summarize specific information they had modified or added to the document as a result of recent studies. First, they inserted the fact Grass Pickerel was reassessed by COSEWIC in 2013 with no change to its status. Next, findings that showed 1) few Grass Pickerel underwent long distance migrations and 2) those that moved were the largest and in the best condition, were incorporated. The presenter created a new table for the document (Table 2) that consisted of aquatic vegetation taxa found in association with Grass Pickerel, and highlighted that vegetation was consistent across its range.

A participant asked whether new values needed to be incorporated into the document, such as Area of Occupancy numbers. The presenter made a note to include these values. Another participant commented that the new vegetation table was a good idea, especially with regards to the earlier discussion on seed banks. The participant requested more clarification between riparian and aquatic (i.e., instream) vegetation for the table.

The presenter moved on to a section on sediment composition, where they had inserted substrate values based on recent sampling in the Ontario region. A participant noted that the predominant substrate seemed to be clay. Another participant suggested removing the Wisconsin substrate data that were currently in the document. The presenter agreed.

The presenter then moved on to discuss spawning and specified that they had added some more references, and the notion that Grass Pickerel may also spawn in the fall. A participant made the observation that fall spawning likely occurs but it is unknown how successful it is. The presenter moved on to talk about nursery habitat, and explained that some sites consistently had higher catches of YOY, but that the reason for this is unclear.

The presenter discussed the idea of habitat hot spots, citing anecdotal evidence and results from Beaver Creek sampling where Grass Pickerel were consistently found. The presenter noted that loss of connectivity seemed to have large implications on the species, for example in Jones Creek and Twenty Mile. They explained that the largest fish (i.e., productive females) moved in Beaver Creek, which has great importance for population dynamics and gene flow. The presenter then highlighted the importance of the use of woody debris objects, such as those found in Beaver Creek habitats.

The presenter brought up the subject of spawning terraces, which were created as part of the natural channel design with the goal of providing spawning habitat for the species during construction activities. The presenter suggested that additional detail/guidance should be included with respect to the design of in-channel spawning terraces that would incorporate characteristics most suitable for spawning and nursery use (i.e., wide and flat vs. narrow and steep terraces).

A discussion followed about spawning and the spawning terraces. A participant explained that the design of the steep terraces was meant to address the issue of stranding, and acknowledged it is a good idea to modify their design to be flatter and wider. A participant asked how long these spaces are used, and the presenter explained that it depends on the duration of flooding; the hope is that the fish would use them until they reach 50 mm. Other participants noted that factors such as the rate at which water recedes and the cost of construction likely affected the design of the terraces.

A participant mentioned the constructed pools and suggested there should be a depth recommendation in the document. The presenter agreed to add a specific section regarding pool construction and depth. They then referred to a section regarding stormwater quality treatment and sediment removal, and a note was made to obtain clarification for this section.

The presenter also asked whether a new section should be included that incorporates comments from an earlier conversation regarding erosion control measures. This was left for discussion for the following day.

The last point the presenter addressed had to do with trends in Grass Pickerel abundance in Beaver Creek, particularly with the large difference between Garrison West (low CPUE) and Garrison East (high CPUE). The presenter reaffirmed their belief that drain maintenance is likely to have little impact on Grass Pickerel in Beaver Creek given that it was conducted in the west branch where numbers of the species were low; however, if the impact occurred in the east branch it would likely have a greater effect on this species at risk.

DRAFTING OF FUNCTION, FEATURES AND ATTRIBUTES TABLE

Presenter: Bill Glass

The presenter worked through the FFA with the participants by going through each row (e.g., spawning to embryonic stage, YOY, juvenile to age 1, and adult) and column (e.g., function, features, attributes). After some discussion on the attributes section of the first row, the term 'open water' was removed. The 'greater than' (>) and 'less than' (<) signs in front of water depths were incorrect and were reversed. The phrase 'eggs to adhere to above the substrate' was added. A participant noted that the species uses both aquatic and terrestrial vegetation for habitat, once the habitat is flooded. This was incorporated as 'dense submerged aquatic vegetation or terrestrial vegetation/dormant perennial' in the attributes section.

The phrase 'and associated wetlands' was changed to 'or associated wetlands' in the features column. After some discussion of wording around seasonal flooding, a note was made to add a point later 'for requirement for flooding in some areas for vegetation purposes'. Next followed a discussion on whether geography was considered a feature. It was decided to leave geography in for now, as the table can get revised as needed. Georgian Bay and Lake St. Clair were added as other geographical areas where Grass Pickerel are found. This was changed for all life stages. The attributes column was addressed again, and a motion was made to remove 'spawning initiated immediately after ice out' to 'spawning initiated when water temperature in the margins reaches 8–12 °C'. After some discussion of the term 'clear, calm, water' the word 'clear' was taken out, in order to incorporate conditions when turbidity occasionally occurs. This was also removed for the other life stages sections.

A discussion ensued about whether the FFA is supposed to represent optimal/preferred habitat, because many fishes use less than preferred conditions when necessary. It was clarified that for the purposes of this discussion the FFA should refer to habitat the species currently occurs in. One of the participants agreed to check the latest template for a table that has an extra column for preferred habitat and to distribute it to the rest of the group.

Next, the YOY factors were discussed. Participants agreed to adjust some wording and the phrase 'shallow or flooded margins' was incorporated into the attributes column. A discussion followed about whether it was important to include specifics about substrate. It was agreed to leave them in for now and to specify the dominant substrate found in Grass Pickerel surveys. As a result of the conversation, it was recommended to look for potential non-linear relationships with substrate data across the species' range. Another participant suggested including 'low gradient' in the features column, because the relationship may have more to do with topography and not just substrate. This was inserted in all rows.

The participants then discussed the idea of groundwater input. It was decided to change 'no groundwater input' to 'warm water' in the attributes section. This was also changed in the juvenile and adult sections. The discussion continued, with some participants thinking there was

unwarranted negative content regarding groundwater input in the mitigation document, and it was suggested that the topic be revisited when the mitigation document is discussed.

A participant pointed out that the prey items in the YOY section were overly specific and all-inclusive, and it was agreed to remove the specific diet components. After some discussion on the importance of overhanging cover, the term 'overhanging objects' was removed, and this was subsequently deleted in other rows.

The juvenile stage was then addressed. A participant noticed the size ranges for the juvenile stage were incorrect, and the minimum was changed to '100 mm'. It was recommended to remove the preferred water depth. A participant suggested deleting 'sometimes gravel, peat...' and 'ample' in the attributes section, as well as feeding preferences for both juvenile and adult rows.

A detailed discussion regarding the importance of overwintering habitat and anoxic conditions followed. It was decided that another row should be added to the table in order to properly address this. After much debate, the final row refers to all life stages with the function being described as 'refugia'. The features cell contains the same information as described for juveniles, while the attributes cell specifies 'access to refuge areas with sufficient habitat to decrease probability of die-off in winter or drought periods'. The participants were satisfied with the outcome.

DRAFTING OF MITIGATION GUIDE REVIEW UPDATE

Presenter: Julia Colm

Prior to opening up the discussion to revisions, the presenter sought clarification on the stormwater treatment section (discussed during their earlier presentation) because the authour had to leave early. The authour confirmed that they were writing about certain measures used in urban and rural areas to manage stormwater and sediment loads that could affect fish habitat. It was decided that the section should remain in the document.

The discussion was opened to participants to provide comments on the Coker et al. (2016) mitigation document. A participant noted that the document referred to 125 streams and that some of the Grass Pickerel data presented during this meeting should be organized in a similar manner. They also mentioned the notion of culvert replacement versus a whole drain cleanout as a potential option for future drain maintenance.

There was a conversation about seed banks and it was decided that this should be identified as a knowledge gap. There was consensus that there should be research (literature search/expert advice) focused on upstream seed bank, recolonization rates, replanting and drought situations. A participant raised a concern about what is realistic and expected of contractors if certain constraints are put in this mitigation document, especially if there are external factors such as a drought. It was clarified that this document is meant to give the SAR group advice and that any requirements would be built into contingencies and a plan. It was confirmed that this answer satisfied the participant's question.

A participant inquired whether it is known how long Grass Pickerel can survive without cover (pg. 6 of the document). The presenter stated there is nothing in the literature regarding that specific topic. The participant suggested that a section emphasizing using an adaptive approach that will act to avoid hot spots during maintenance should be added to the document. The presenter agreed to include this content.

Many of the comments referred to specific wording in the document that no longer exists (e.g., DFO policies such as the DFO Risk Management Framework, HADD) and needed to be

changed or removed. It was also identified that some of the wording and sentences that were developed for the FFA should be transferred to the mitigation document. Some specific comments included: define 'connection' and provide an example where habitats have been lost (p. 6), change the word 'efficient' drainage when talking about low water levels (p. 9), identify winter kill issues, retain section on groundwater flows (pg. 9), and update references to appendices and management plan as needed. It was noted that the draft of the management plan for Grass Pickerel is in progress and that some of the basic principles being discussed could be incorporated into that document.

Other comments were provided for revision, including small editorial comments (e.g., scientific names of vegetation species). The presenter confirmed they would incorporate the edits provided by the participants into the final draft.

A discussion followed about the importance of linking the threats to habitat functions to the *Fisheries Act*. Consensus was reached that the FFA table would remain as is and another table would be created that contained pathways and threats. An example of the latter is to be provided to the presenter. A participant identified the importance of mentioning substrate and its relevance in the document, as per earlier discussion. The section about spawning terraces was brought up, and the presenter acknowledged that this was something that needed to be described properly in the document.

A participant suggested that siltation should be quantified (p. 9), because at some level it will negatively affect Grass Pickerel. It was also recommended that content about the species using offline pools be removed because surveys showed that they were not used. Page 11 of the document refers to the management plan and it was stressed that the guidelines on this page be cross-referenced with the updated management draft prior to final publication, including the reference to 4 °C for spawning. A participant suggested changing the term 'abundant' as a qualitative descriptor in the aquatic vegetation table, and it was decided that the table would be adjusted so that genus and species are in one column and the order is by frequency and then scientific or common name.

A participant raised their opinion on the language surrounding groundwater input and maintaining preferred temperatures. In addition they mentioned that the science advice provided in this document should be consistent with two other science advisory reports (Crown Marsh and Little Bear Creek).

The final discussion focused on alternative mitigation measures. Participants explained the two-stage ditch method vs. the submerged bench method; in the case of the former there is a continuous baseflow whereas benches are generally only submerged during storm events. It was recommended that explicit language be used in the document because an engineer and superintendent might have a different idea of each concept. This is also discussed in the Little Bear science advisory report and should be cross-referenced. A participant noted that there should be content explaining that sediment loads/dredgeate should not be loaded into the floodplain and connecting habitat.

All of the comments were heard and the discussion concluded. The mitigation guide will be revised based on these discussions and circulated to the meeting participants for final comment, prior to being published as a Canadian Manuscript Report of Fisheries and Aquatic Sciences.

DRAFTING OF SCIENCE ADVISORY REPORT SUMMARY BULLETS

Presenter: Bill Glass

Leading into the presentation, the Chairperson explained that the summary report bullets are meant to be high level points encompassing the content presented throughout the meeting and are placed at the beginning of the CSAS report.

Beaver Creek Summary

After some discussion of the bullet points presented from this presentation, reference to density-dependent effects was removed because of a lack of evidence in the data. A participant reiterated that year-class strength should be recalculated by taking the length data and assigning ages for all of the fishes caught in 2009. Further modification was made to include a statement about the objectives of the study. After more discussion, 'was associated with a drought in 2012' was replaced with 'observed after a significant drought in 2012'.

Age and growth study

The first bullet was removed because the data represented a non-random sample. The remaining bullet regarding mortality rates was left as is but a note was made to seek clarification on mortality calculations from the first author. After some discussion it was decided that more bullets would be written in this section and sent around for review after the document is revisited. Some participants mentioned that it would be helpful to have a more generalized bullet point and an additional one that discusses comparison of age and growth structures. Another participant thought it would be useful to mention that lethally obtained structures are necessary to properly interpret age and growth, for the purpose of research and animal care permit processes.

Effects of drain maintenance study

With regards to the first bullet point, a participant suggested the time scales be specified as opposed to writing 'short' and 'long'-term. Another participant suggested that the word 'population' be included. The next bullet point was presented in point form and participants clarified that it needed to be summarized into sentence form and the time period specified.

A discussion followed about mixed sampling effort and balanced design with regards to the study. A participant recommended that an analysis be conducted on the sampling design and if needed, subsequent data analyses should be modified. One approach could be to use one sampling date per year or only use data from the first three seine passes. The group agreed that this should be a two-step process: first address the sampling effort and then see if the data need to be re-analyzed.

A participant raised a concern over the wording regarding increased abundance in the reconstructed reach post-maintenance. It was decided that further detail should be provided, for instance clarifying that the western branch was initially an area of low abundance. Participants agreed that the wording should represent the uncertainty regarding the cause of increased numbers, as it is unknown whether abundance increased or Grass Pickerel relocated to that reach. It was acknowledged that subsequent bullet points might need to be adjusted based on this new wording. A participant suggested finding a consistent terminology around the phrase 'natural stream channel' within the document.

A discussion followed on the summary bullets that described recommendations for future drain maintenance. Participants worked together to determine appropriate wording that pertained to the results of this study and would also be transferable to similar projects. Some participants

worried that reference to long-term monitoring would have a negative outcome on potential future proponents (i.e., municipalities) and that in many situations this scientific advice becomes the prescriptive document due to a lack of available management documents. A participant explained that this should not be looked at as a predictive document and the scientific advice would not apply to every situation, as each project is assessed on a case-by-case basis. It was suggested to mention a knowledge gap, as these are the findings that were observed but it is difficult to provide concrete evidence as there was no control treatment. Another participant suggested that mentioning habitat condition (e.g., pools, vegetation) may be more important than fish metrics (e.g., abundance). It was decided that the summary bullets would be completed after reviewing the notes and recordings from this meeting.

General discussion

It was observed that summary bullets were missing from other presentations. The presenters agreed to work on the summaries from their talks (genetic analysis, movement study, population modelling) and send them around to the group for review, as well as associated presentation slides to be included for reference.

A participant asked whether the physical work that was done on the drain addressed the original problem. They wondered whether a bullet could be created that focused on understanding the impact on the physical landscape. A discussion followed and it was agreed that contractors involved in the work (e.g., drainage superintendent) should be contacted because much information is missing or has not been provided. Currently only one of four reports has been received. A participant wondered how sampling by DFO since 2012 may have additionally impacted the Grass Pickerel population. Another participant thought it would be important to include survey recommendations when a BACI sampling design is not possible.

The organizers thanked everyone for their participation and confirmed that they would be sending around documents for review once they were re-drafted in the near future.

NEXT STEPS

Revised summary bullets were sent around to the group for their comments on 14 November 2016 and a follow-up meeting was organized in Burlington and via teleconference on 16 November 2016. Participants who could not attend submitted their comments via e-mail beforehand. The following bullets summarize the main points that were addressed by participants and the discussions that followed:

- The group decided against incorporating new bullets that discussed key vegetation and habitat features, including spawning terraces, maintaining that they should be described in detail in the text.
- A bullet was created that highlighted the infrequent movement of Grass Pickerel and that areas with high abundances of the species should be protected from drainage activities when possible.
- The phrase 'where submerged aquatic macrophytes can establish' was added to an existing bullet that discussed future drain activities.
- First two bullets were combined into one bullet as they contained redundant information.
- Wording in a bullet was changed to 'future drainage projects' when discussing pre- and post-construction monitoring in order to encompass a greater range of projects.
- The term 'long-distance movement' was defined (0.9 km–3.1 km) and the proportion of individuals who moved was inserted (13.3% in 2009, 5.6% in 2010).

- The term 'natural channel reconstructions' was modified to 'natural channel principles'.
- A bullet was modified to read 'natural channel design'.
- The phrase 'during spawning period' was added to a bullet explaining population modelling results.
- There was a discussion about the relevance of the population modelling results to the habitat at Beaver Creek. Modelling was done with pre-construction data (in terms of habitat analysis) and bathymetry data for the region do not exist. It was suggested that a bullet point summarizing modelling output be clarified/concluded with some statement that refers back to habitat at Beaver Creek.
- After some discussion it was decided that the bullet referring to the BACI effects would remain as is, without specifics, as others had commented that it was too long.
- A bullet describing future drain maintenance activities was modified with 'these features were incorporated during reconstruction of Beaver Creek' as opposed to both 'maintenance and reconstruction'.
- There was some discussion about writing a bullet to specify habitat conditions in the western reach: relatively poor habitat pre-maintenance and increased habitat quality (for Grass Pickerel) post-reconstruction activities could be a potential reason for the increase in abundance that was observed. The group decided against this because none of the members had firsthand experience with the site in question and the habitat parameters being discussed (i.e., quantity) had not been measured.
- There was a discussion about clearly distinguishing between 'maintenance' and 'reconstruction' in the document and bullet points because they represent two different things, and reconstruction activities is what led to enhanced habitat and the minimal effects of drain maintenance that was observed.
- Lastly, there was a discussion about the science advice recommendations based on this meeting and other publicly available information regarding the success of this project. It was agreed that the other information would be reviewed to see whether it aligns with the scientific advice that has been generated and that DFO's documents would be publicly available as well.

REFERENCES CITED

Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Review Considerations and Mitigation Guide for Habitat of the Grass Pickerel (*Esox americanus vermiculatus*). Ontario Great Lakes Area - Fisheries and Oceans Canada, Burlington, ON. v + 18 p.

Kleinert, S.J., and Mraz, D. 1966. Life history of the Grass Pickerel (*Esox americanus vermiculatus*) in southeastern Wisconsin. Wisconsin Conservation Department Technical Bulletin No. 37. 40 p.

Kramski, N.A.M. 2015. Conservation of fishes in altered ecosystems: the movement ecology of listed Grass Pickerel in an agricultural drain. Thesis (M.Sc.). University of Guelph, Guelph, ON. 50 p.

Lorenzen, K. 2000. Allometry of natural mortality as a basis for assessing optimal release size in fish-stocking programmes. Can. J. Fish. Aquat. Sci. 57: 2374–2381.

Minns, C.K. 2003. An area-per-individual (API) model for estimating critical habitat requirements in aquatic species-at-risk. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/074. i + 21 p.

Minns, C.K., Randall, R.G., Moore, J.E., and Cairns, V.W. 1996. A model simulating the impact of habitat supply limits on northern pike, *Esox lucius*, in Hamilton Harbour, Lake Ontario. Can. J. Fish. Aquat. Sci. 53: 20-34.

APPENDIX 1: TERMS OF REFERENCE

Impacts of agricultural drain maintenance in Beaver Creek on Grass Pickerel (*Esox americanus vermiculatus*), a fish species at risk

Regional Peer Review – Central and Arctic Region

October 4-5, 2016
Burlington, ON

Chairperson: Lynn Bouvier

Context

Beaver Creek, a tributary of the Niagara River, is classified as a municipal drain in the Town of Fort Erie. Drain maintenance was required to clear obstructions and improve drainage of private lands. Beaver Creek is home to a relatively large population of Grass Pickerel (*Esox americanus vermiculatus*), a resident of several drains in the Niagara Region. Grass Pickerel is listed as Special Concern under Schedule 1 of the Species at Risk Act. This species has specific habitat requirements (i.e., dense aquatic vegetation, clear water, low flow, temporally flooded riparian zones) that conflict with the undertakings and objectives of most drain clean-outs.

The Town of Fort Erie proposed a drain clean-out within a provincially significant wetland that included the removal of three debris jams, excavation, and re-grading of approximately 988 linear meters of Beaver Creek. Overall, this impacted 2.8 hectares of fish habitat surrounding the westerly tributary of Beaver Creek. This drain maintenance was conducted in the fall of 2011 on the west branch of Beaver Creek. Natural channel design principles were incorporated into the construction to mitigate the impacts of a traditional drain cleanout. Five pools were constructed, along with two offline floodplain pools, to improve water storage and create additional fish habitat.

There was concern that the drainage works may have a significant impact on Grass Pickerel populations present in this system. Fisheries and Oceans Canada (DFO) Species at Risk Program has requested advice from DFO Science to help assess the impacts of the drain maintenance and reconstruction activities on Grass Pickerel in Beaver Creek and determine appropriate monitoring techniques for assessing adverse effects on the species.

Objectives

The objectives are to provide advice on the effects of drain maintenance on Grass Pickerel and its habitat:

1. Determine the impacts of drain maintenance and reconstruction activities on Grass Pickerel populations in Beaver Creek.
2. Develop monitoring techniques that could be used to detect impacts on Grass Pickerel populations.
3. Update existing recommendations (Coker et al. 2010) and provide additional mitigation measures that could be used to minimize the effects of future drain clean-outs on Grass Pickerel.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document(s)

Expected Participation

- Fisheries and Oceans Canada (DFO) (e.g., Science and Resource Management sectors)
- Ontario Ministry of Natural Resources
- University of Toronto
- Town of Fort Erie
- Other invited experts

References

Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Review considerations and mitigation guide for habitat of the Grass Pickerel *(Esox americanus vermiculatus)*. Can. Manuscr. Rep. Fish. Aquat. Sci. 2941: vi + 18 p.

APPENDIX 2. PARTICIPANTS

Name	Affiliation
Balint, Dave	DFO, Species at Risk
Bouvier, Lynn (Chair)	DFO, Science
Buck, Kathleen	DFO, Fisheries Protection Program
Coker, George	Portt and Associates
Colm, Julia	DFO, Science
Cvetkovic, Maja (Rapporteur)	Note taker, DFO, Science
Drake, Andrew	DFO, Science
Dunn, Shelley	DFO, Species at Risk
Empson-Laporte, Jacqui	Ontario Ministry of Agriculture, Food and Rural Affairs
Glass, William	DFO, Science
Kemp, Alain	DFO, Species at Risk
Koops, Marten	DFO, Science
Lujan, Nathan	University of Toronto
Mandrak, Nick	University of Toronto
Reid, Scott	Ontario Ministry of Natural Resources and Forestry
SM, Bahar	AHYDTECH Geomorphic
Smith, Ian	UEM Consulting
van der Lee, Adam	DFO, Science

APPENDIX 3: AGENDA

Impacts of agricultural drain maintenance in Beaver Creek on Grass Pickerel (*Esox americanus vermiculatus*), a fish species at risk

Regional Science Advisory Meeting

Canada Center for Inland Waters, North Seminar Room
Burlington, ON

Chairperson: Lynn Bouvier

Tuesday, 4 Oct 2016

Time	Presentation	Presenter
9:00–9:15	Introductions, objectives of science review, and process	Lynn Bouvier
9:15– 9:50	Grass Pickerel: General information and overall summary of Grass Pickerel sampling efforts	Julia Colm
9:50–10:25	Beaver Creek sampling summary	Julia Colm
10:25–10:40	Health Break	
10:40–11:25	Population genetics of Grass Pickerel in Canada	Nathan Lujan
11:25–12:00	Effects of drain maintenance and reconstruction on Grass Pickerel abundance and habitat in Beaver Creek	Bill Glass
12:00–13:00	Lunch (not provided)	
13:00–13:25	Movement of Grass Pickerel in Beaver Creek	Nick Mandrak
13:25–14:00	Age and Growth of Grass Pickerel in Beaver Creek	Julia Colm
14:00–14:15	Health Break	
14:15–14:50	Population modelling and MAPV	Marten Koops
14:50–15:20	Updates to Grass Pickerel mitigation guide	Julia Colm
15:20–16:30	Discussion	

Wednesday, 5 Oct 2016

Time	Presentation	Presenter
9:00–10:15	Discussion continued and drafting of summary bullets	
10:15–10:30	Health Break	
10:30–11:45	Drafting of summary bullets	
11:45–12:00	Closing remarks	